

U.S. ARMY-BAYLOR UNIVERSITY
GRADUATE PROGRAM IN HEALTH CARE ADMINISTRATION

A COST-BENEFIT STUDY FOR DESIGNING AN
INFORMATION SYSTEM TO MONITOR THE
UTILIZATION OF DIAGNOSTIC ANCILLARY AND
PHARMACY SERVICES AT THE NATIONAL NAVAL
MEDICAL CENTER, BETHESDA, MARYLAND

A GRADUATE MANAGEMENT PROJECT

SUBMITTED TO

LIEUTENANT COMMANDER EHRESMANN

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ABSTRACT

This cost-benefit study was conducted to determine the ratio of costs to benefits for creating an information system to monitor the utilization of diagnostic ancillary and pharmacy services. The study consisted of three parts. The first part was to determine the cost of the system. The estimated discounted net present value of the cost was \$373,700. The second part of the study was to determine the potential benefits of the system. A review of literature revealed that automated feedback when combined with an educational intervention reduced the demand for diagnostic ancillary and pharmacy services. The percentages of reduction as reported by the literature was then applied to the workload at the National Naval Medical Center (NNMC). This resulted in a discounted net present value of \$2,313,400 for the benefits. The total net present value for the proposed system was \$1,939,700. The third part of the study was to determine whether there were any effective alternatives to purchasing the information system. It was determined that the Expense Assignment System, Version IV (EAS IV) would offer all of the capabilities of the proposed system except for daily feedback of the utilization of ancillary services.

The study recommended that NNMC not purchase a separate system but use the capabilities of the EAS IV. The study also recommended that a request be submitted to change the requirement for the EAS IV to provide daily feedback of utilization. Another recommendation was to utilize the Composite Health Care System (CHCS) more effectively to assist in monitoring the utilization of ancillary services.

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CHAPTER 1

INTRODUCTION

Conditions Which Prompted the Study

As part of the transition to TRICARE, the National Naval Medical Center (NNMC) will no longer receive funding based upon its level of workload. Funding instead will be based upon a capitated system. In the past, higher levels of workload resulted in higher levels of funding, so there was no incentive to control utilization of services. Capitation, however, provides an incentive to control the utilization of services. Under capitation, the population served is the basis for funding, so controlling the utilization of health care services, such as ancillary diagnostic and pharmacy services, results in more funding being available for other mission essential activities, such as maintaining medical readiness, developing specialized treatment services (STSS) and promoting wellness.

A key requirement of capitation is that health care providers must monitor and control the costs associated with providing health care. Ancillary diagnostic services, such as

laboratory and radiology testing, and pharmacy services represent a major portion of these costs. According to the fiscal year 1995 Medical Expense and Performance Reporting System (MEPRS), NNMC spent over thirty-five million dollars for ancillary diagnostic and pharmacy services. The ability to control and reduce the utilization of ancillary diagnostic and pharmacy services is a strategic interest of NNMC.

Statement of the Problem

Health care providers, and other resource managers, need to be able to monitor the costs associated with the utilization of diagnostic ancillary and pharmacy services. At NNMC, this is difficult to accomplish because the existing Department of Defense (DoD) legacy information systems that record this type of information are fragmented. For example, the Composite Health Care System (CHCS) records transactions involving provider ordering of ancillary diagnostic and pharmacy services, while the Expense Assignment System, Version III (EAS III) assigns costs for ancillary diagnostic and pharmacy workload. The problem is that these systems are not integrated. Labor-intensive, time-consuming processes are required to transform the data in these systems into information, such as provider level

cost-effectiveness, that can be used to make management decisions.

Decision makers need a common database that assists with monitoring and controlling the utilization of diagnostic ancillary and pharmacy services and provides more detailed cost accounting information. The ideal information system would offer relatively easy access to the data contained in both CHCS and EAS III. This would provide all resource managers, including clinicians, with the capability of monitoring the costs associated with providing diagnostic ancillary and pharmacy services. This information could be combined with outcome information to provide more cost-effective, higher quality care. The ideal information system would provide utilization information according to the ordering provider, diagnosis-related groups (DRGs), current procedural terminology (CPT) code, or individual patient.

Literature Review

Strategies to Modify Utilization

The value of an information system which monitors the utilization of diagnostic ancillary and pharmacy services lies in its ability to provide feedback to health care providers so that they can modify their utilization of those services. Victor Fuchs observed that the behavior of providers controls and determines a significant portion of the cost of medical care (Fuchs 1974). Donabedian has also described the role that providers play in the complex relationship between quality and cost. In Donabedian's model, the quality of care improves when harmful elements of care are eliminated, or it remains the same if non-value added elements of care are eliminated (Donabedian, Wheeler, and Wyszewianski 1982). Grossman observed that "although there are large-scale forces that influence the economic behavior of the health care delivery system, it is the physician who has primary authority to make decisions regarding the use of resources." Therefore, the control of health care expenditures requires the development of efficient provider practice habits (Grossman 1983). According to Rosenstein, the key to cost-effective health care is the control of "physician-driven variable costs" such as orders for ancillary diagnostic

services and pharmaceuticals (Rosenstein 1991).

Eisenberg and Williams studied some potential methods for inducing providers to participate in cost-containment efforts. Their review of literature concluded that provider "self-imposed restraint will turn out to be the most effective force for ensuring rational cost control while preserving the highest possible quality of care." They recommended that hospital administrators find new approaches for identifying hospital costs and develop innovative strategies for providing their medical staff with the information that they need to lower their costs of delivering health care (Eisenberg and Williams 1981).

The literature identifies five interventions that might be effective for improving provider awareness of the cost of health care. This awareness can lead to reducing expenditures for diagnostic ancillary and pharmacy services. These five interventions are:

1. Education. Educational programs have only temporary effects upon provider cost awareness and ordering behavior. Unless there are ongoing educational programs, providers will return to their baseline level of test usage. Reinforcement is required for this type of behavior modification to be effective (Eisenberg and Williams 1981; Chapman 1995).

Clinical practice guidelines are an example of an educational intervention. A review of studies indicates that these have been ineffective as a single intervention for positively influencing provider practice patterns (Greco and Eisenberg 1993; Davis et al. 1992). Greco and Eisenberg concluded that clinical practice guidelines have been largely unsuccessful because providers prefer to rely upon their own or colleague experiences instead of expert recommendations, they have difficulty with applying the guidelines to specific patients, there are few financial incentives to apply guidelines, or they fear guidelines may lead to malpractice suits (Greco and Eisenberg 1993).

There are two exceptions to the ineffectiveness of clinical practice guidelines. The exceptions are the use of "opinion leaders" (clinicians whom their peers consider to be trustworthy sources of clinical information) to distribute guidelines and "academic detailing" that targets individual providers for education. However, the training of opinion leaders and academic detailing are very expensive, labor intensive methods and neither has been shown to work outside a research setting (Greco and Eisenberg 1993).

2. Feedback. The use of feedback appears to be more effective than education alone in modifying provider ordering behavior. Eisenberg and Williams described feedback as being more effective than education alone because, if it was properly structured, it could effect providers' sense of achievement and their desire to excel. Their concept of feedback involved subtle reinforcement or admonition for current behavior. They proposed that over-utilization should be monitored by hospital committees. They also noted that studies suggest that education combined with feedback is more effective than education alone (Eisenberg and Williams 1981). Grossman's (1983) survey of the literature regarding provider cost-containment strategies also reached the same conclusion that educational strategies with an emphasis upon the feedback of cost information have been shown to be effective in modifying provider ordering behavior. In the studies where feedback did not affect provider practice patterns, one or more of the elements of effective feedback was missing. For feedback to be effective, providers must realize that their current practice patterns require changing. The provider who receives the feedback must be capable of acting in response to it, and the feedback must be timely so that providers can respond to it immediately (Greco and Eisenberg 1993).

The Davis et al., (1992) review of studies on continuing medical education confirmed Eisenberg and William's hypothesis that education combined with feedback produces positive results. They reported that educational intervention (academic detailing, computer-generated information, didactic presentations, printed materials, and workshops) when combined with feedback and reminders positively affected physician performance in eighteen studies and had negative or inconclusive results in eight studies (Davis et al. 1992). The Davis et al., (1995) subsequent review of literature noted that audit with feedback as a single intervention resulted in positive outcomes in ten studies and negative outcomes in fourteen studies. However, when feedback was combined with an educational intervention, positive results were noted in sixty-four percent of the studies. They also noted that physician reminders, a type of feedback, was an effective single method intervention that affected positive change in twenty-two of twenty-six studies (Davis et al. 1995).

The Davis et al., (1992) study also examined the effect upon physician performance and health care outcomes when educational interventions, such as clinical practice guidelines, are combined with feedback interventions. They concluded that in all fourteen studies where physician performance was measured, there was a

positive effect on physician performance. The results on health care or patient outcomes were mixed; five studies reported positive patient outcomes, while four studies reported negative or inconclusive patient outcomes (Davis et al. 1992). They noted that practice guidelines when used alone were not effective in positively changing physician practice patterns and that the use of feedback and reminders overcomes "the logistical and sociological barriers to facilitating optimal physician performance" (Davis et al. 1992). In examining twenty-four interventions targeted towards utilization of diagnostic ancillary services, the researchers noted that seventeen of the interventions resulted in significant positive changes while seven did not (Davis et al. 1995).

3. Administrative actions. This involves the use of laws, regulations, or institutional policies and practices to modify provider ordering behavior. Examples of this type of intervention include requiring written justification for orders, assigning maximum quotas for tests that residents are allowed to order each day, requiring prior approval before ordering, and modifying the formulary (Eisenberg and Williams 1981). These policies or practices can change behavior by creating barriers to undesirable practices. Greco and Eisenberg noted that the

arbitrary nature of administrative actions, while effectively changing behavior, have the potential to lead to the subsequent harm of patients (Greco and Eisenberg 1993).

4. Provider participation in group processes. Eisenberg and Williams believe that providers will not respond favorably to forced change unless they agree to it. They see the need for the active participation of providers with identifying problems, planning and implementation of review processes, and making the decisions regarding feedback, rewards, and penalties concerning the problem (Eisenberg and Williams 1981). Greco and Eisenberg suggest that providers will oppose any changes they perceive as a threat to their livelihood, self-esteem, sense of competence, or autonomy. Interventions that decrease providers' decision-making authority, reduce their income, challenge their professional judgments, or appear to compromise patient care are more likely to fail. Provider involvement in the change effort makes it less threatening. Providers must perceive any proposed changes as beneficial, or at least nonmaleficent, to patients. They cite continuous quality improvement (CQI) as being able to support change because CQI focuses upon improving the quality of care (not controlling costs), and there is no presupposition that providers' practice patterns must be changed. However, Greco and

Eisenberg could not identify studies showing that patient outcomes are improved by this approach (Greco and Eisenberg 1993).

5. Financial rewards and penalties (incentives).

Observational studies suggest that different methods of reimbursement result in different styles of practice. These studies indicate that the elimination of positive financial incentives lead to declining expenditures for diagnostic ancillary and pharmacy services (Greco and Eisenberg 1993). Many managed care organizations and insurers maintain profiles of provider utilization of ancillary services. This is a type of financial incentive because these profiles are a real, or implied, threat to physician income. The threat is that the managed care organization will use utilization profiles to determine which providers may participate in their health care plan. Providers with excessive utilization profiles may no longer be allowed to treat members enrolled in the health care plan (Chapman 1995).

The Davis et al., (1992 and 1995) studies as well as the Greco and Eisenberg (1993) study concluded that no single type of intervention is inherently effective. Multiple interventions tend to be far more effective than single interventions (Davis et

al. 1992; Davis et al. 1995; Greco and Eisenberg 1993). Greco and Eisenberg recommended that the following questions should be asked before implementing an intervention:

- Is the chosen intervention appropriate for the desired change in practice?
- Do providers support the proposed change to their practice? For example, providers are likely to oppose cost-cutting changes unless it can be shown that patient outcomes will not be adversely affected. If there is no data on patient outcomes, then providers may be unwilling to change their practices.
- How will the intervention be perceived by providers? The additional requirements of some interventions may be viewed as a burden to providers. Providers must accept the need for change before change can be implemented, otherwise, the outcome may be less than optimal. Cooperation and collaboration with providers are needed to enhance the chances for a successful intervention (Greco and Eisenberg 1993).

Outpatient Studies with Automated Feedback

There have been many studies in both the ambulatory and the inpatient care settings examining the effect that computerized feedback, regarding the costs associated with ancillary services, has upon provider ordering of ancillary services. Most of those studies have involved academic medical centers that are somewhat similar to the operating environment of the National Naval Medical Center. This literature review examines four of those studies involving the ambulatory care setting and five studies involving inpatient care.

The exception to the academic medical center studies is the Berwick and Coltin (1986) study of the Harvard Community Health Plan health maintenance organization (HMO). They studied the twelve highest volume blood tests and roentgenograms ordered by the plan's primary care physicians. An intervention was designed that allowed the physicians to receive cost feedback on their individual rates of use as compared with their peers. Eleven of the twelve tests showed some decrease. The total test usage decreased by 14.2 percent. They noted that cost feedback appeared to decrease the variability in rates of test usage by 8.3 percent, but that this change was inconsistent across all tests. The study did not compare the effect of combining of cost

feedback with an intensive educational intervention. However, the researchers noted that in a busy HMO group practice, providers may not have enough time to receive an intensive educational intervention. Their study did not compare patient outcomes between high and low utilizers of tests (Berwick and Coltin 1986).

The format of their cost feedback report included a list of clinicians coded to ensure anonymity, the number of encounters, the number of tests ordered per one hundred encounters, and the computed costs per one hundred encounters (based on commercial laboratory charges) for each clinician in the preceding month. Clinicians were listed in rank order by cost of tests ordered per one hundred encounters. The rank order of the recipient was shown by highlighting the individual's data on the summary report. While the report did not make any comparison of patient acuity, the clinicians were urged to consider the age, sex, and morbidity of their patient panels in comparison with their colleagues. Berwick and Coltin concluded that "peer comparison feedback on rates and cost of test use holds promise for reducing absolute rates of testing and variation among physicians within work groups." Their recommendation was that educational and managerial efforts that increase opportunities for physicians to

compare their own practices with those of their peers should be beneficial to health care organizations (Berwick and Coltin 1986).

The Tierney, Miller, and McDonald (1990) study conducted in 1988 used an on-line information system to determine the effect of informing physicians of the charges for outpatient diagnostic tests ordered at the academic General Medicine Practice of Regenstrief Health Center in Indianapolis. Their hypothesis was that "physicians will alter their behavior when given information about the cost side of the cost-benefit equation." Their intervention allowed providers, while entering on-line outpatient orders, to see on their computer screens the charge for the test being ordered and the total charge for tests for the patient on that day. The intervention group ordered fourteen percent fewer tests per patient than the control group. Their total charges for tests per visit were thirteen percent (\$6.68 per patient) lower than the control group. In a follow-up study after the intervention period, the cost difference between groups decreased by seventy-five percent.

The researchers concluded that physicians need continual reminders of the charges for tests for them to maintain their consciousness of costs. They also concluded that computer-generated reminders were more effective than educational intervention. As measures of quality, the researchers found no statistically significant differences when comparing rates of hospital admissions, visits to the emergency room, or subsequent outpatient visits between the intervention and control groups. Based upon 1988 prices, the information system used by this intervention cost forty-five thousand dollars and served 120 physicians who provided fifty thousand annual visits to twelve thousand patients. The estimated cost savings of expanding the intervention throughout the primary care practice was estimated to be \$250,000 for a cost benefit ratio of nine to fifty (Tierney et al. 1990).

In 1984, Hershey et al., (1986) conducted a study of the effects of automated feedback upon outpatient prescription charges. Their intervention was conducted with the General Medicine residents at Cleveland Metropolitan General Hospital. They hypothesized that "a computerized feedback program can inform physicians on prescribing costs and acquaint them with lower cost alternate regimens. The objective was to reduce the

total ambulatory prescribing charges for medical outpatients." The intervention consisted of providing the residents with monthly computer printouts summarizing the prescriptions filled at the hospital pharmacy over the providers' signature. The average number of provider prescriptions and charges were provided for comparison purposes with other residents. Dependent variables included mean charge per prescription, mean charge per patient, and the number of prescriptions for each patient. The intervention reduced the mean charge per prescription by 6.5 percent for a 9.7 percent total charge per patient. This resulted in a benefit-to-cost ratio of more than 50:1. However, statistically significant savings did not appear until nine months after the intervention began. Based upon attitude surveys of residents, they had a positive view of the program. A survey of residents concluded that they thought that charge information was important and that they wanted to receive that type of information. Residents expressed these attitudes both before and after the intervention. The study concluded that computer feedback of prescription charges reduced subsequent outpatient prescription charges (Hershey et al 1986).

There was a follow-up study to determine the effect that a newsletter in conjunction with automated feedback would have upon the charges for outpatient prescriptions. The newsletter addressed different therapeutic topics each month and provided and an in-depth discussion of one of the drug classes that were listed on the monthly feedback form. The newsletter, although positively viewed by the residents, did not alter their drug ordering practices (Hershey, Goldberg, and Cohen 1988).

Inpatient Studies with Automated Feedback

The Parrino (1989) study, while similar to the Hershey et al., (1986) study, involved the antibiotic orders for inpatients at Boston University Hospital. His study did not result in cost savings similar to Hershey's. Parrino's intervention was to send automated monthly letters to physicians (both surgical and non-surgical), who were in the upper fifty percentile of antibiotics expenditures advising them of their antibiotic expenditure compared with their peers. He concluded that the feedback did not reduce antibiotic utilization, but that the feedback system had other benefits for the organization. The feedback system made it possible to identify other strategies for containing costs, such as highlighting the differences between services

(surgical patients received more antibiotics but the total surgical antibiotics costs were less because they used less expensive antibiotics). It also allowed the hospital to identify physicians with high cost utilization (thirty percent of physicians accounted for eighty percent of all antibiotic costs). Parrino noted two drawbacks to his study. One drawback was that the feedback was received several weeks after the patient was discharged. He predicted that concurrent instead of retrospective feedback might have yielded better results. Another drawback was that the attending physicians received the feedback instead of the house officers who wrote most of the prescriptions (Parrino 1989). Greco and Eisenberg cited Parrino's study as an example of a flawed feedback system (Greco and Eisenberg 1993). Other studies have had results indicating that automated feedback systems contribute to reducing the costs associated with inpatient pharmaceuticals (Rosenstein and Stier 1991; Billi et al. 1992; Tierney et al. 1993).

The Cohen et al., (1982) study provides another example of a flawed feedback system. Their study was conducted on the general internal medicine service at Cleveland Metropolitan Hospital. They hypothesized that "providing physicians with information about the costs of their testing would lead to a reduction in

test usage but that this reduction would diminish when the feedback information ceased." Their intervention method was to provide each team of physicians with a report of the preceding day's laboratory tests that reported the patient's name, type of test ordered, and total cost. Diagnostic radiology tests were reported weekly in the same format. One group of providers received information about laboratory test costs while the other group received feedback on diagnostic radiology test costs. There was no sharing of comparative data between teams (Cohen et al. 1982).

The teams that did not receive laboratory test cost data experienced the largest decrease in laboratory test usage. Contrary to expectations, their laboratory costs decreased more significantly than their diagnostic radiology costs. The researchers attributed the drop in laboratory usage to the active interest that the leaders of the diagnostic radiology data group showed in the idea of cost control, while the leaders of the laboratory usage group were more passive about implementing cost control. The researchers attributed the longer lag time for diagnostic radiology feedback as the reason that its usage did not decline as expected. The chief of the diagnostic radiology data group held informal discussions with team members concerning

cost control, and the senior resident required the junior physician, who consumed the most resources, to buy the box of doughnuts for the weekly team meeting. In contrast, the leaders of the laboratory data group did not make any attempts to influence the test ordering of their residents. The study's conclusion was that simple cost feedback mechanisms will not by themselves assure reduction in test usage. Physicians must be prepared and willing to use the cost data (Cohen et al. 1982). Greco and Eisenberg cited this study as an example of a flawed feedback system (Greco and Eisenberg 1993). It also demonstrates the effectiveness of multiple interventions for cost control (Davis et al. 1992; Greco and Eisenberg 1993; Davis et al. 1995).

Other studies have been more successful at creating an effective feedback system. The Pugh et al., study (1989) conducted on two medical wards at the Duke University Medical Center "concluded that charge feedback alone is effective in a teaching hospital for decreasing charges." The intervention consisted of a computer-generated statement that summarized the following items on each inpatient: the probable diagnosis-related group (DRG) assignment, current diagnoses, procedures performed to date, cumulative charges (both total and by cost centers, such as laboratory, radiology, or room), and length of stay to date.

For comparison purposes, the sheet also displayed average charges and average length of stay for patients assigned the same DRG who were admitted during the previous year. The sheets were placed on the patient's chart each day on the feedback ward only. No other educational interventions were performed. The study's independent variables were age, sex, DRG relative weight, race, and public/private pay status (Pugh et al. 1989).

The study concluded that house staff who received feedback had an eighteen percent (1.4 days) decrease in length of stay, a seventeen percent (\$860) decrease in total charges, an eighteen percent (\$333) decrease in room charges, a twenty percent (\$308) decrease in diagnostic studies, and a twenty-eight percent (\$271) decrease in treatment charges when compared with the control group. The researchers attributed the large decreases in charges to the study design that excluded patients whose course of treatment was determined prior to their arrival. This was done since the house staff had very little decision-making control over those patients. Patient outcomes did not appear to be adversely affected. There was no statistically significant difference between in-hospital mortality and preventable readmissions between the two groups. Functional status scales and disease-specific outcomes were not analyzed between the two

groups of patients (Pugh et al. 1989).

The providers participating in the study completed attitude surveys. Before the intervention, seventy-nine percent of providers anticipated that the feedback would be very helpful or helpful, but after the intervention the positive rating dropped to fifty-two percent while the negative rating (doubt usefulness of the feedback) increased from six percent to thirty percent. The house staff reported changes in behavior such as trying to decrease length of stay (forty-three percent), ordering fewer tests (thirty-nine percent), repeating tests less frequently (thirty percent), changing the sequence of ordered tests (twenty-six percent), and using fewer intravenous drugs (thirteen percent) (Pugh et al. 1989).

The Billi et al., (1992) study modified the Pugh et al., (1989) study by adding an educational intervention. Their study was conducted with the internal medicine services at University of Michigan Hospitals. The educational intervention consisted of a brief monthly discussion (fifteen minutes in duration) regarding the importance of cost in decision making. This discussion involved the faculty, house officers, and students. The estimated cost for twelve orientations was \$0.22 per case. Study participants also received a short pamphlet listing the

patient charges for over 150 commonly ordered tests and services, including room rates. The pamphlet described twenty cost-saving strategies. The estimated cost for producing and distributing the pamphlets was \$0.50 per case. Similar to Pugh et al.'s study, on the third day of the hospital stay, an interim bill was placed in the progress note section of the medical record. The interim bill described hospital charges accrued to date. Faculty members were encouraged to discuss at least one interim bill each week during attending rounds. The hospital's existing billing system produced the interim bills, so there was no additional cost for the bill. However, the precertification clerk estimated the length of stay (LOS) and DRG reimbursement per case and added this information to the bill that was then placed in the chart. The estimated additional cost for this was \$0.88 per case. The total cost per case for the intervention was \$1.60 which resulted in a hospital cost savings per case of \$209. The ratio of savings per case was 209:1.60. The intervention reduced the average length of stay 7.8 percent (0.44 days) while charges were reduced 7.1 percent (\$341). Audits of the quality of care detected no significant differences between the intervention and the control groups of patients. The researchers concluded that the intervention produced savings without adversely affecting the

quality of care (Billi et al. 1992). Unlike the Pugh et al., (1989) study, the Billi et al., (1992) study did not indicate that patients whose course of outcome was decided prior to their arrival were eliminated from the study. That may account for the decreases reported in the Billi et al., (1992) study as being less in overall magnitude than those reported by the Pugh et al., (1989) study.

The Tierney et al., (1993) study was conducted in 1988 involving direct order entry by physicians on the inpatient internal medicine service at Wishard Memorial Hospital in Indianapolis. The hospital's network of clinical workstations was configured to display the patient's charge for each item, while the menus for tests listed the most cost-effective tests for common problems and displayed recommended testing intervals. The workstations provided the cost of each test, the last time it had been ordered, and made recommendations concerning expensive drugs, tests, and procedures. The dependent variables were total charges per hospital admission, the length of stay (LOS), and hospital costs. The intervention resulted in a thirteen percent (\$887) decrease in total charges per admission. Total hospital costs were reduced thirteen percent (\$594) for intervention admissions, with eleven percent lower bed costs, twelve percent

lower test costs, and fifteen percent lower drug costs. Hospital LOSs decreased by eleven percent (.89 day) for intervention teams. However, the study noted warned that the actual savings to the hospital may be less than the study indicated because many of the hospital's costs are fixed (Tierney et al. 1993).

The preceding studies suggest that there are potential savings to health care organizations for implementing an information system that gives feedback to providers concerning the costs associated with the care that they provide. Alan H. Rosenstein, the Director of Medical Resource Management at California Pacific Medical Center, has created a medical resource management model that combines the interventions of provider feedback with provider education. Rosenstein's resource management model is intended to allow physicians and hospitals to monitor health care services and improve their delivery of more cost-efficient, high-quality medical care. The model stresses hospital-physician education, communication, and interaction for attaining internal control over the system. The model requires a hospital to evaluate its economic strengths and weaknesses, isolate unwanted variances, and improve the total delivery of health care (Rosenstein 1991). By applying the medical resource management model to major joint procedures (DRGs 209 to 212),

California Pacific Medical Center reduced the average length of stay by fourteen percent, pharmacy charges by eleven percent, laboratory charges by thirteen percent, and total average charges per patient were reduced by \$1,000. The study reported that radiology charges increased by three percent, but the authors did not provide any comments regarding this anomaly (Rosenstein and Stier 1991).

Applying Information to Manage Resources

Providers must actively participate for the resource management model to be a functional tool. Rosenstein recommends provider education, data analysis and presentation as the keys for obtaining provider participation with the resource management model. Information building begins with discussions of the external constraints that are being placed upon the practice of medicine. This is followed by a presentation of data that is understandable and relevant to the provider's practice of medicine. At this point, provider acceptance is expected to occur. The data highlights particular problem areas for providers. They are then encouraged to provide input to solve the problem. Interested providers and department heads work together to develop action plans to reach desired goals. This

information is then presented at a general forum. Individual providers receive follow-up counseling as needed. The final component is regular monitoring and revision as necessary (Rosenstein 1991). This is an example of provider participation in group processes that was recommended by Eisenberg and Williams (Eisenberg and Williams 1981).

Pacific Medical Center created an "Ancillary Resource Management Task Force" which includes the department heads from Laboratory, Radiology, Nuclear Medicine, Pharmacy, Physical Therapy, and Respiratory Services. Task force members analyze ancillary resource utilization from their perspectives. The task force, department heads, and staff examine each department's top twenty-five services or procedures to identify inappropriate utilization and develop alternatives to improve efficiency. This is a paradigm shift by holding department heads accountable for service utilization instead of maximizing the units of work that they produce (Rosenstein 1994).

Pacific Medical Center also determines utilization profiles for individual providers. These profiles are based upon provider resource utilization data that is stratified according to DRGs and submitted to each provider along with a comparison to the group norm. This information is shared with providers in a

nonadversarial manner. According to Rosenstein, this information attracts the attention of providers and encourages their participation in designing alternatives for change. This is done as part of continual quality improvement to improve the "entire spectrum of care." Newly arrived residents and interns attend seminars on health economics, so they can understand the effects of cost-containment on the hospital and upon their future practices. Institutional level training in cost-containment is also held for employees involved with nursing, administration, finance, information systems, and other care activities. Rosenstein notes that this education is likely to be forgotten unless the process is continually monitored with reminders, feedback, and control (Rosenstein 1994).

Meyer and Feingold cite the need to integrate financial analyses with clinical information as a rational and objective basis for re-engineering clinical processes. They note that managed care requires financial staff to work closely with providers "to understand what resources are consumed and why, costs associated with using these resources, and alternatives that may positively affect resource consumption while maintaining or improving clinical quality" (Meyer and Feingold 1995). They recommend costing out critical paths, so providers can gain a

greater understanding of resource consumption and costs while financial staff increase their understanding of the clinical aspects of care. After an interdisciplinary committee validates the costed-out critical path, it can be used for retrospective comparisons. This approach should reduce patient care costs and provide more accurate information concerning what a "service unit" (e.g., a standardized procedure-specific inpatient intervention) actually costs the health care organization. This is vital for managed care contracting, including the development of package pricing, service line "carve out" programs, and capitated plans. If implementation of the critical path is successful in modifying physician practice patterns and variations in clinical practice are reduced, then the average cost associated with these targeted groups of patients becomes predictable. This decreases risk for the health care organization. One large hospital used this method and reduced costs of their cardiovascular service line between ten and twenty-six percent per procedure. Their laboratory charges were reduced an average of \$800 per surgical patient, with operating room charges reduced by \$750, pharmacy charges reduced by \$550, and radiology charges by \$350 (Meyer and Feingold 1995).

Cost Accounting for Hospital Services

"Top-down" and "bottom-up" are the two basic approaches for determining the costs of hospital services. Private sector, top-down costing is based upon the amount charged for a service and assumes that there is a consistent relationship between overall charges and overall costs. Using this method, the total costs of operating a department are divided by gross revenues to determine a ratio. This ratio is then applied to the charge for procedure to determine its cost. Top-down costing is less expensive to implement and maintain than bottom-up systems, but it provides less useful information to managers. However, it is used by the majority of hospitals (Nemes 1990; Orloff et al. 1990; Hill and Johns 1994).

The ratio of costs to charges (RCCs) is an example of a top-down costing method used by hospitals (Orloff 1990). When using RCCs, procedure-level costs are determined by applying the ratio of departmental overall costs to charges for individual procedures. This uses the average cost of care for the average patient and does not reflect the resources actually consumed by the care for a specific patient. It assumes that there is a given amount of material and labor in a unit of output, and these costs will vary around an average cost per hour or unit of

production. These charges are based upon market prices, so there is not necessarily a direct relationship between charges and the costs incurred to perform the procedure (Orloff et al. 1990). The ratio of costs to charges (RCCs) is one of the least sensitive measures for costing procedures. It is highly aggregated and lacks precision (Hill and Johns 1994). Top-down costing does not measure productivity, and it cannot be used for variance analysis (Riccolo 1988).

The bottom-up approach tracks the costs associated with the inputs (labor, material, and overhead) required to perform a procedure (Orloff 1990). There are several approaches to bottom-up costing. Determining actual costs is the idealized form of bottom-up costing. Determining actual costs usually requires direct observation of the procedure. It is the most precise form of costing, but it requires extensive effort and resources to achieve. Other approaches to bottom-up costing, such as relative value units (RVUs) and standard costing, can be used alone or in combination with actual costs (Orloff 1990). Unlike top-down costing, bottom-up costing provides the level of detail required to aggregate costs in different ways. Aggregating at the DRG level allows for costs to be compared with DRG reimbursement. Aggregating costs according to the provider supports resource

control and utilization review. To examine and evaluate provider behavior and practice patterns, the number and cost of procedures are collected for specific patients and these costs are aggregated to attending providers. Costs can also be aggregated to product lines (e.g., cardiovascular services, cancer care, etc.) in order to support marketing analysis (Hill and Johns 1994).

Bottom-up cost accounting systems can be used to determine fixed and variable costs. The ability to separate fixed from variable costs associated with patient care supports departmental control of costs, the forecasting of incremental volumes, establishing new business lines, and entering into managed care contracts (Hill and Johns 1994). They are also used to determine marginal costs. Marginal costs, the cost of providing services to an additional patient, is required for effective decision making. If a health care organization relies on average full costs (costs that include variable and fixed costs per unit), then the cost increase associated with an increase in volume will be overstated. Similarly, the cost savings from a decrease in volume will be overstated (Hill and Johns 1994). Bottom-up costing can also support flexible budgeting and performance evaluation by comparing actual costs with expected costs. By

measuring these variances, managers can determine the effectiveness of cost controls for the level of volume that actually occurred (Hill and Johns 1994).

An accurate allocation scheme is important for bottom-up cost accounting systems. The allocation scheme should assign overhead costs to the procedures that "caused" the overhead. The step down schedule used in the Medicare cost reporting is commonly used to provide the statistics for allocation of costs (Hill and Johns 1994).

The use of relative value units (RVUs) is a more precise measure for allocating overhead. Relative value units (RVUs) represents the relative amount of resources consumed by each procedure. First costs are allocated to major cost components (materials, labor, and departmental overhead), then the RVU is applied to the costs of the major cost components to determine the costs of each procedure (Hill and Johns 1994).

The standard cost collection method is another means of cost allocation. The standard cost collection method assigns a dollar amount of resources to each cost component of a procedure. Cost component standards are determined through time and material studies, industry standards, or estimates from department managers. RVUs and standard costs must be regularly updated to

ensure accuracy, since relationships between procedure cost components change over time (Hill and Johns 1994).

Process costing is another type of bottom-up cost accounting. Process costing uses averages of costs over a large volume of services (Finkler 1994). An example of process costing would be costing based upon DRGs. This is not a very accurate measure of cost because it takes the average costs of providing care for patients with a specific DRG and applies it to each patient regardless of the resources that they actually consumed (Riccolo 1988). The advantage of this approach is that it is relatively inexpensive and less likely to encounter employee resistance because it involves the lowest degree of employee performance monitoring (Finkler 1994). Traditionally low volume service organizations, such as hospitals, have preferred process costing because the costs of capturing specific cost information usually exceeds the benefits gained (Riccolo 1988). However, as competition grows in the health care marketplace there is a perceived need to employ more accurate means to identify costs (Hill and Johns 1994).

Job-order costing provides more detailed and accurate information than process costing because it assigns the specific resources used to produce an output to that unit (Finkler 1994). Job order costing is designed to determine all of the material, labor and overhead costs incurred by a patient during an episode of care. Job order costing will usually require some averaging of costs, but these averages are generally based upon smaller volumes than process costing. Most cost accounting systems are hybrids rather than "pure" process or job-order costing systems. Hybrids allow some of the costs to be accumulated by process costing while other costs are based upon job-order costs (Finkler 1994).

The standard costing method uses predetermined costs, usually based upon historical costs or special studies, to estimate what it costs to produce one unit of output (Finkler 1994). Standard costing can be used to predict future costs of treating patients as well as to estimate previous costs of service units. Cleverley proposed a patient-centered standard costing model using the patient as the ultimate object of costs. His model requires standard treatment protocols (STPs) and standard cost profiles (SCPs) subsystems (Cleverley 1987). Standard treatment protocols are the intermediate products, or

service units (SUs), consumed during the patient's episode of care. Standard cost profiles are the profile of resources utilized to produce the service units to treat the patient. Standard treatment protocols (STPs) are similar to job order cost sheets where each job gets a separate cost sheet listing all of the labor and materials needed to treat the patient. Cleverley recommends developing STPs for every DRG. Standard treatment protocols use standard cost profiles to identify the variable and fixed costs per service unit. Direct SUs are identified and recorded for standard treatment protocols. A direct SU is one associated with a given patient. Indirect SUs need not be specifically identified for the patient; they are allocated to the direct SUs. An indirect SU is a product or service provided to another department instead of to a patient. An estimate of the allocated cost of the indirect SU can be used. If there are numerous SUs, then standard cost profiles should be developed for the most common ones. Costs can be arbitrarily assigned for less common SUs (Cleverley 1987).

The standard cost profile (SCP) consists of the service unit (SU) being costed and the profile of resources needed to cost the service unit. A standard cost profile for a given SU should list

the resource expense categories of direct expenses such as labor, materials, departmental overhead, and allocated overhead. The SCP should also categorize the expenses as variable or fixed. The distinction between variable and fixed costing is used for incremental decisions regarding price or volume, as well as flexible budgeting and management control systems. Hospitals should determine the variable cost as well as the average fixed cost and add these together to get the average total cost. Departmental overhead does not vary with volume or activity, so a simple average, using estimated total SUs, can be used to determine overhead. A simple average can also be taken for other allocated costs. Cleverley recommends that instead of allocating costs, more service units should be identified and applied as direct service units (e.g. meals, laundry, medical records, housekeeping). Cleverley estimates that identifying more SUs would reduce a hospitals indirect costs from 50 percent of total costs to 25 percent or lower. For a cost accounting system to provide information for management decisions, it should identify as many direct SUs as possible (Cleverley 1987).

Price, efficiency, and volume variances are determined by standard cost profiles. Price variance is the difference between the costs incurred and the standard cost or rate multiplied by

the actual quantity consumed. Efficiency variance is the difference between the actual quantity consumed and the standard quantity multiplied by the standard cost. Volume variance is the difference between expected and actual output multiplied by the average fixed cost per unit. Intensity variance is the difference between the actual quantity of service units consumed and the standard service units multiplied by the cost per service unit. Intensity variances should be based upon variable elements rather than fixed elements because they represent costs incurred in response to specific actions, such as ordering a laboratory test. Intensity variances are associated with physician practice patterns; therefore, intensity variances should be aggregated to attending physicians. Cleverley believes physicians should help develop the standard treatment protocols that determine the quantity of service units required to treat the patient (Cleverley 1987). Standard treatment protocols are similar in concept to clinical pathways.

In Cleverley's model, a product line represents an amalgamation of patients. Clinical specialties are product lines because they can be eliminated or expanded. Individual diagnosis related groups (DRGs) are not product lines because an individual DRG cannot be eliminated. The role of budgeting is to translate

product line decisions into specific sets of resource expectations. For effective budgeting, management must know what it costs to produce a service unit and the quantity and variety of service units required to treat a patient (Cleverley 1987).

Another method of bottom-up costing is activity-based costing (ABC). Activity-based costing improves the measurement of financial performances by tracing activities back to the events that generate costs (Canby 1995). According to Peter Drucker, the traditional product costing methods, such as job-order and process costing, have not been successful for most service organizations because they do not reflect the needs of knowledge-based service organizations (Drucker 1995). He believes the inability to substitute capital for labor to perform work in knowledge-based organizations makes the distinction between fixed and variable costs irrelevant to service organizations. Service organizations should focus on the cost of their total system realizing that their costs are fixed costs for any given period of time. According to him, activity-based costing is the best method to show the impact of changes in costs of every activity on the results of the whole organization (Drucker 1995). Others have recommended activity-based costing as the best method for determining the full cost per service unit

for hospitals (Chan 1993; Canby 1995).

Activity-based costing defines the costs associated with organizational processes or activities, instead of determining direct and indirect costs (Canby 1995). This avoids the problem of process and job-order costing that allocate indirect costs based upon volume. Volume based allocation tends to overcost high volume services and undercost low volume services (Chan 1993). In activity-based costing, cost drivers are used as the basis for allocating indirect costs. Activity-based costing can be used to more accurately determine Cleverley's standard cost profiles. This is done by determining the activities and resources required for the standard treatment protocol. A cause and effect relationship is determined for the indirect costs required by the standard treatment protocol. Activity-based costing identifies all of the relevant costs and any non-value added activities associated with the standard treatment protocol. This can reduce the time and effort associated with accomplishing the standard treatment protocol (Chan 1993).

The costs of measurement and the costs of errors are the two costs associated with any cost accounting system (Chan 1993). The costs of measurement includes the costs associated with routing and computing the cost information. These costs are less

with process or job-order costing than with activity-based costing (Chan 1993). This is due to the relatively high level of effort required to identify and measure the numerous cost drivers required to support activity-based costing. The costs of errors are greater with process or job-order costing because they provide less accurate cost information (Chan 1993). Activity-based costing should only be implemented when the costs of errors far exceeds the costs of measurement (Chan 1993). This is most likely to occur in a highly competitive market because firms cannot afford to make mistakes in costing and pricing their services (Chan 1993).

The costs associated with activity-based costing include the costs of a detailed study of an organization's logistics and accounting information systems and the costs of tracing resource consumption to specific activities. Organizations with a large volume of activities require more numerous cost drivers. This increases their measurement costs (Chan 1993). Another drawback of activity-based costing is that it requires management to actively monitor employee performance. This can lead to employee dissatisfaction with their relative loss of autonomy (Finkler 1994). For some organizations, it may be technically infeasible to implement activity-based costing due to the complex nature of

their activities (Chan 1993).

Chan recommends combining activity-based costing with the development of Cleverley's standard cost profiles and standard treatment protocols. This should enable managers to identify unprofitable treatments and take corrective actions such as reducing or eliminating non-value added activities associated with the treatment. Since activity-based costing considers activities outside of the organization, it can assist organizations with changing their mix of services to better meet the needs of their customers (Chan 1993). Canby notes that activity-based costing is time consuming and labor-intensive requiring total commitment from the organization in order to be effective. It requires regular review and validation of the cause and effect relationships as the organization changes (Canby 1995).

Status of Cost Accounting in the Private Sector

According to a 1991 study, 75.8 percent of hospital chief executive officers rate cost accounting systems as important or somewhat important (Hard 1991). Despite this perceived need for cost accounting systems only twenty four percent of hospitals have automated cost accounting systems that collect procedural-

level costs (Hill and Johns 1994). Of these, seventy-nine percent have systems that separate fixed and variable costs and make comparisons of budgeted and actual costs at the departmental level, while only seventeen percent compare actual and budgeted costs at the DRG level. Fifty percent use microcosted standards to derive costs while thirty-three percent use RVUs, and seventeen percent use the ratio of costs to charges. Forty percent use time and material studies to derive costs, while thirty-five percent rely upon departmental managers' estimates and twenty-five percent use industry standards. The following uses are made of costing information: strategic planning and forecasting (seventy-five percent); product line profitability (fifty-eight percent); budgeting (fifty-three percent); and performance evaluation (thirty-eight percent). One of the reasons given for not implementing cost accounting systems is that revenue is determined by market rates and competition not by costs. (Hill and Johns 1994).

Development Stages for Cost Accounting

Young and Pearlman describe four stages in the development of bottom-up cost accounting systems (Young and Pearlman 1993). In the first stage, hospitals improve their overall cost accounting systems. The second stage requires the assessment of cost behavior within departments. The third stage emphasizes controlling overall costs, while the fourth stage requires the design of new cost-conscious administrative systems (Young and Pearlman 1993).

First stage cost accounting systems capture full cost information and identify direct and indirect costs. This supports long-term decision making such as determining product line profitability. First stage systems track each patient throughout the hospital encounter by recording all tests, procedures, and other resources consumed by the patient. These systems use the full costs of the resources consumed to determine the full cost of services per patient. The patients are then aggregated into different categories such as DRGs or product lines for management decisions regarding long-term profitability (Young and Pearlman 1993).

Second stage cost accounting systems are designed to support short-term decision making. They must be able to identify the marginal costs associated with the services provided by the hospital. This requires being able to identify the fixed and variable costs associated with a service or product line. In order to do this, the cost behaviors associated with all of the cost centers are analyzed. This requires one to two years of analysis to obtain accurate and complete information regarding fixed and variable costs. For each DRG, information concerning fixed and variable costs is applied to the job order cost information captured by the first stage cost accounting system. Each DRG's service units, number of service units, variable cost per service unit, and total variable cost per cost center are then used as the basis for determining the marginal cost for the DRG. The DRG marginal cost is used as a competitive price to offer discounted services to purchasers such as health maintenance organizations (Young and Pearlman 1993).

Third stage cost accounting systems shift the focus of cost accounting from departments to patients. This is necessary because the stage one and two systems are concerned with retrospective costs while third stage systems are concerned with prospective costs. This requires the introduction of activity-

based costing to identify cost drivers. The six basic cost drivers that influence a health care organization's costs are case mix, volume, resources per case, input unit prices, input efficiency, and fixed facility costs. First stage cost accounting systems focus on case mix and volume cost drivers, while third stage cost accounting systems focus on the other four cost drivers. A third stage cost accounting system tries to convert unprofitable DRGs into profitable DRGs by changing the patterns of resource consumption for patients and hospital operations.

Physicians are responsible for the resources per case cost driver, while department managers are responsible for the input unit prices and input efficiency cost drivers. Clinical treatment protocols (i.e., the preferred treatment pattern for a typical patient for a given diagnosis) determine the resources per case cost driver. The development of clinical treatment protocols, or critical pathways, is required for third stage cost accounting systems. Professional services departments, such as ancillary diagnostic services, and support service departments, such as logistics, develop administrative efficiency protocols. Administrative efficiency protocols include the expected rates of production for technicians, nurses, and other employees. These

protocols are used to determine and control the input price and the efficiency of these departments. Third stage cost accounting systems require physicians and department managers to develop specific standards for measuring their performance (Young and Pearlman 1993). This is similar to the standard costing model developed by Cleverley (1987).

Third stage cost accounting systems require physicians and department managers to base their budgets on their estimates of the cost drivers that they control. The planning department and clinical chiefs of services are responsible for forecasting the number and mix of cases. Health care administrators, accountants, and clinical chiefs of services estimate the DRG price per case. Clinical chiefs and physicians within their departments determine the appropriate resources to be used per case. Health care administrators, such as the head of purchasing, project input unit prices. Department managers determine the input efficiency for their departments. Clinical chiefs specify the fixed facility costs for their departments. The efforts of all these different agents are required to determine the overall budget for the facility (Young and Pearlman 1993).

Third stage cost accounting systems support responsibility accounting (Young and Pearlman 1993). Responsibility accounting attempts to measure financial outcomes and assign those outcomes to the individual or department responsible for them (Finkler 1994). Responsibility centers are identified based upon their actual or potential control of resources. Professional and support service departments are designated as standard expense or cost centers. This is because they have well-defined units of activity that drive their costs; however, physicians rather than their managers control the volume and mix of their units of service. The patient's condition determines the number of service units provided by support service departments. Due to their manager's relative lack of control, flexible budgeting is used to measure the performance of standard expense centers. Administrative overhead departments, such as fiscal or personnel, are designated as discretionary expense centers because there is no well-defined relationship between their inputs and outputs and they do not earn revenue. Clinical care departments can be designated as either standard expense centers or profit centers. If they are designated as standard expense centers, then the department managers are only responsible for managing the resources per case. If clinical care departments are designated

as profit centers, then they are responsible for controlling the case mix, volume, and input unit price as well as the resources per case. The advantage of the profit center structure is that it can be used as the basis for an incentive system to reward physicians for admitting patients whose DRGs make the highest average contribution to fixed costs. The variable cost per service unit from professional and support services departments becomes the transfer price that clinical care departments use to purchase services. A potential problem with this approach is that the responsibility for cross-subsidization decisions (offsetting DRGs with a low average contribution to fixed costs with DRGs with a higher average contribution to fixed costs) passes from senior management to clinical department heads. Relatively few hospitals have adapted stage three cost accounting systems (Young and Pearlman 1993).

The fourth stage of cost accounting arises out of the need to prevent responsibility centers from pursuing their own individual self interests at the expense of the organization. Fourth stage cost accounting systems require activity-based accounting. These systems enable managers to determine the source of non-value added costs regardless of organizational boundaries. This aids them with the identification of

opportunities for interdepartmental collaboration to reduce costs. Departments, by working together, can achieve greater efficiency in the delivery of physician ordered resources and more effective control of their administrative overhead costs. Nonfinancial performance indicators, such as waiting and transport times, are used in fourth stage cost accounting systems. To control administrative overhead costs, the managers of administrative overhead departments must determine the relationship between inputs and outputs of activities within their departments and the relationship between these inputs/outputs to the activities of other departments. Only a handful of hospitals have adopted fourth stage cost accounting systems (Young and Pearlman 1993).

This fourth stage of cost accounting with its focus on inputs, outputs, and relationships among activities is similar to the Department of Defense Corporate Information Management (CIM) Functional Process Improvement (FPI) Initiative. This initiative uses activity modeling and activity-based costing. First activity modeling is used to define inputs, outputs, and relationships among activities. Then activity-based costing (ABC) identifies the cost relationships associated with those activities. Some of the goals of this initiative are to

establish cost and performance measures for benchmarking; to eliminate non-value added activities; to streamline value added activities; and to integrate processes, physical assets, and data to gain economies of scale. The CIM motto is to simplify, integrate, and automate. Automation should only occur after the underlying business process have been validated. CIM requires the development of a business case before new information systems can be approved. CIM business process improvements are expected to utilize existing DoD assets and lead to the development of shared data systems and software that can be reused within the DoD (U.S. Department of Defense 1993).

Designing Cost Accounting Systems

For most health care organizations, a cost accounting system should be integrated with other databases and information systems (Bialzak and Broccolino 1993). Many of the data elements required by a cost accounting system are common to other systems. The benefits of integrating with other systems are to avoid duplication of data entry, eliminate discrepancies between data systems, and to simplify software and hardware needs. The general ledger, the billing system, the materials management system, and the payroll system are commonly integrated into cost

accounting systems. The general ledger provides information concerning the overhead costs that are included in direct costs. The billing system provides patient, provider, and procedure identification. The materials management system provides information on the costs of supplies. In an ideal system, as disposable supplies are used their cost would be bar coded into the cost accounting system and assigned to the appropriate cost center. The cost of reusable supplies would be divided by their expected useful life in terms of procedures. The expected useful life in terms of procedures can be obtained through an objective source, or by multiplying the useful life in years by the average number of uses per year. The payroll system provides salary information on facility staff providing direct patient care. This can be done by using either the actual salary and benefit costs or an average costs associated with a class of care providers. The general rule is to average salaries if the difference is due to seniority, and use the exact figure if the salary difference is based upon qualifications required to perform the procedure. The general ledger provides indirect patient care salary costs, which are allocated as indirect costs (Bialzak and Broccolino 1993). A basic cost accounting system, not including hardware, can be purchased for fifty thousand

dollars but, depending upon features and the size of hospital, it can cost hundreds of thousands of dollars (Nemes 1990).

Keegan describes several features that should be considered when designing a cost accounting system (Keegan 1987). These features include departmental cost pools, cost elements, direct versus indirect costs, fixed and variable costs, and reporting requirements. For departmental cost pools, management must decide whether the patient services departments or all expense generating areas will be included in the system. The number of departments reporting to the system increases the costs of the system. Keegan recommends focusing on key departments for the system prototype while ensuring that the system is capable of adding more departments in the future. Cost elements include variable direct salary, fixed salary, variable departmental overhead, and fixed general overhead. As the number of cost elements increase, the cost of maintaining the system increases. Keegan warns against including more elements in the system than the hospital can afford to maintain. The distinction between direct and indirect costs must be consistent for all departments being costed. For example, supplies may be a direct cost for one department while being an indirect cost for another. Often a consensus must be reached to distinguish between fixed or

variable costs. Keegan notes that most hospital labor costs are fixed. The frequency and timeliness of reporting will have a direct impact upon the costs of the system (Keegan 1987).

Purpose

The purpose of this study is to determine the ratio of costs to benefits for creating an information system to monitor the utilization of diagnostic ancillary and pharmacy services. This will require identifying and determining a cost for the elements needed for the information system, such as hardware, software, programming, system documentation, and customer support. The independent variables to be considered include the costs of designing, purchasing, installing, implementing, and maintaining the system. The dependent variables are the potential cost savings from implementing the information system. The premise for the study is that if information concerning the costs of resources utilized to provide care can be distributed, then the knowledge of these costs may positively effect provider ordering behavior. This should result in lower, more cost-effective utilization of diagnostic ancillary and pharmacy services. The hypothesis is that it is economically feasible to develop such an information system and that implementation of that system will

modify provider ordering behavior reducing the utilization of diagnostic ancillary and pharmacy services.

CHAPTER 2

METHODS AND PROCEDURES

This cost-benefit analysis estimates the cost or total expense of acquiring an information system and compares those costs with the estimated dollar value of the benefit created by the proposed information system. Information systems can have both qualitative and quantitative benefits associated with their introduction and usage. Worthley and DiSalvo (1989) note that it is difficult to assign a dollar value to the qualitative benefits of information systems, such as improved access to information, improved organizational communication, and improved quality of care). Therefore, this analysis did not attempt to assign a dollar value to these potential benefits. The quantitative benefits were measured in terms of reducing the costs associated with the demand for ancillary diagnostic and pharmacy services.

For this study, the cost of ancillary diagnostic services and pharmacy services was based upon data from NNNMC's FY 1995 MEPRS report. The data was drawn from the MEPRS Stepdown Workfile based upon contributing MEPRS codes for the following

ancillary workcenters: Clinical Pathology (MEPRS code DBAA); Diagnostic Radiology (MEPRS code DCAA); and Main Pharmacy (MEPRS code DAAA). The workcenters that received services from the previously mentioned ancillary workcenters were Internal Medicine inpatient services (MEPRS code AAAA), Internal Medicine outpatient services (MEPRS code BAAA), Military Sick Call (MEPRS code BHAA), and the Acute Care Clinic (MEPRS code BHAE). It was an assumption of this study that the FY 1995 MEPRS report comprehensively recorded and accurately assigned the actual costs generated by the diagnostic ancillary and pharmacy services to the receiving clinical workcenters. It was also assumed that the amount of resources consumed by various medical services for diagnostic ancillary and pharmacy services in FY 1995 is a reliable predictor of the amount of services that will be consumed by those services in future fiscal years. For ease of interpretation, all costs used by this analysis were rounded to the nearest one hundred dollars.

In keeping with DoD CIM guidelines to utilize existing DoD assets, the proposed information system was an "interface engine" designed to receive data from NNMIC's existing or soon to be activated DoD standard information systems. The appendix describes a tentative configuration and information processing

procedures for the proposed information system. The proposed information system was designed to receive daily updates of new data and make reports based upon that data available to users with access to the existing NNMC local area network (LAN). The system should not require additional data entry, so data entry costs were not be required for this analysis. These system specifications also form the criteria for the selection of the studies, from the literature review, that form the basis for the benefits portion of this cost-benefits analysis (i.e., the literature review studies must use information systems with capabilities similar to this proposed system).

Quantifying Benefits

While Finkler emphasizes the importance of using variable costs for cost-benefit analyses, he also acknowledges that the cost of accurately determining variable and fixed costs usually exceeds the potential benefit (Finkler 1994). It is a limitation of this study that the fixed and variable cost data cannot be readily determined from the MEPRS report (Miller 1996). The MEPRS report does identify the costs associated with labor and supply usage by the ancillary workcenters in support of the clinical workcenters. For this study, the costs associated with

supplies were assumed to be variable costs. Reducing the cost of supplies was considered to be a direct cost savings to NNMC (i.e., funding not used to purchase supplies would be available for other purchases). The cost of supplies was based upon MEPRS standard expense element codes (SEECs) for "other supplies" (code 26.20) and "pharmaceutical supplies" (code 26.25).

Since NNMC labor is basically a fixed cost in the short term, any labor costs associated with reduced demand for diagnostic ancillary or pharmacy services were considered to be opportunity costs. Finkler defines an opportunity cost as "a measure of cost based on the value of the alternatives that are given up in order to use the resources as the organization has chosen" (Finkler 1994). The assumption is that by eliminating unnecessary diagnostic ancillary and pharmacy services, the labor associated with those services can be utilized by other activities that will produce greater value for NNMC. The cost of labor was based upon MEPRS SEEC for civilian "personnel compensation and benefits" (code 11.00) and "military compensation" (code 11.72).

The first stage of the analysis was to compare the results of the literature survey with the specifications of the proposed information system. Table 1 provides an overview of the studies

examined by the literature review. Based upon this analysis, the Tierney, Miller, and McDonald (1990) and Tierney et al. (1993) studies were rejected because they were based upon an information system that gave providers cost information at the time of ordering. The proposed system will not make cost information available to providers during on-line order entry. The Parrino (1989) study was rejected because it utilized monthly feedback while this system will be designed to provide daily feedback. Similarly, the Cohen et al. study (1982) was not used because it relied upon weekly feedback of information.

Three of the six remaining studies were rejected for the following reasons:

- The Hershey, Goldberg, and Cohen (1988) study did not report any statistically significant differences from the Hershey et al. (1986) study, so the Hershey et al. (1986) study was used.
- The Pugh et al., study (1989) was not used because it is not possible to separate the EAS III data into different treatment protocols for inpatients.
- The results from Rosenstein and Stiers' study (1991) were not used because the EAS III data does not identify specific DRGs.

The three remaining studies: Berwick and Coltin (1986); Hershey et al., (1986); and Billi et al., (1992) were analyzed and became the basis for the benefit portion of this cost-benefit analysis. These three studies are relatively inclusive because they cover diagnostic ancillary and pharmacy services for both outpatient and inpatient services.

Table 1. -- Overview of cost-containment studies involving automated feedback

STUDY	SERVICE	INPATIENT	OUTPATIENT	PHARMACY	LABORATORY	RADIOLOGY
(Berwick and Coltin 1986)	Primary Care		X		(14)%	(14)%
(Tierney, Miller and McDonald 1990)	Internal Medicine		X		(14)%	(14)%
(Hershey et al. 1986)	Internal Medicine		X	(7)%		
(Hershey, Goldberg, and Cohen 1988)	Internal Medicine		X	(7)%		
(Parrino 1989)	Medical/Surgical	X		0%		
(Cohen et al. 1982)	Internal Medicine	X			0%	0%
(Pugh et al. 1989)	Internal Medicine	X			(20)%	(20)%
(Billi et al. 1992)	Internal Medicine	X		(1)%	(36)%	(4)%
(Tierney et al. 1993)	Internal Medicine	X		(15)%	(12)%	(12)%
(Rosenstein and Stier 1991)	Orthopedics	X		(11)%	(13)%	3%

The percentage decreases reported by the Berwick and Coltin (1986) study of outpatient orders by primary care services for diagnostic ancillary services were applied to the diagnostic ancillary supply and labor costs associated with NNMC primary care services. It is difficult to measure the mix of primary and specialty care offered at NNMC (Griffits 1995). Therefore, this study used the Ambulatory Care Clinic and Military Sick Call as the basis for projecting the primary care usage of diagnostic ancillary services. This is a very conservative estimate of primary care services at NNMC, since other clinics, such as Internal Medicine, Pediatrics, and Obstetrics-Gynecology render services that can be classified as primary care. Berwick and Coltin (1986) reported a fourteen percent decrease in utilization of diagnostic ancillary services. This percentage of change was applied to the costs associated with diagnostic ancillary usage by NNMC's Primary Care Clinic and Military Sick Call as reported by the EAS III for fiscal year 1995 to determine the potential cost savings or benefit. A limitation of this approach is that the specific diagnostic procedures used in the Berwick and Coltin (1986) study may not accurately represent all of the diagnostic ancillary services used by the Acute Care Clinic and Military Sick Call. However, it should be noted that Berwick and Coltin

used the highest volume primary care diagnostic ancillary tests for their study, so the fourteen percent decrease should be representative of potential cost savings for other primary care entities.

The same rationale that was previously described for the Berwick and Coltin (1986) study was also applied to the Hershey et al. (1986) study of inpatient medicine utilization of outpatient pharmacy services. Hershey et al. (1986) reported that internal medicine outpatient pharmacy orders decreased by seven percent when providers received feedback concerning prescription charges. For this analysis, the cost associated with outpatient internal medicine demand for pharmacy orders was based upon the costs reported by the EAS III for fiscal year 1995. The experimental group for the Hershey et al. (1986) study consisted of internal medicine residents at a tertiary care teaching hospital which is similar to conditions at NNNMC.

The results from the Billi et al. study (1992) were used for comparison purposes with inpatient utilization of diagnostic ancillary and pharmacy services by NNNMC's Internal Medicine Department. The Billi et al. (1992) study is similar to the Hershey et al. (1986) study because it also was conducted at a tertiary care teaching hospital. The results of the Billi et al.

(1992) study (thirty-six percent decrease in laboratory utilization, four percent decrease in diagnostic radiology utilization, and a one percent decrease in pharmacy services) were applied to the costs for inpatient Internal Medicine diagnostic ancillary and pharmacy services as reported by the EAS III for fiscal year 1995.

DETERMINING COSTS

The costs associated with this proposed information system were the costs associated with the design, implementation, and ongoing maintenance of the system. The primary sources for identifying the elements required for the proposed information system were the literature review and personal interviews. The feasibility and cost of incorporating the data from existing legacy systems into a new information system were based upon estimates provided by Sherikon Incorporated, a commercial vendor with previous experience working with DoD information systems (Burchess 1995). It is a limitation of this study that the risk of the contractor failing to meet all specifications was not evaluated. Another limitation is that cost projections for modifying the interfaces with other systems, as those systems change, could not be determined.

The cost associated with a systems administrator for implementation and maintenance of the proposed system was based upon Salary Table Number 96-OCB for government service workers in grade ten at step increase five; this includes Washington District of Columbia area locality pay. The salary was multiplied by twenty-nine percent to reflect the cost of benefits (Clark 1996). This paygrade and salary was estimated to be commensurate with the duties assigned (Lackey 1995). A limitation of this study is that the literature did not quantify the opportunity cost associated with gathering, distributing, and interpreting the results from the feedback of diagnostic ancillary and pharmacy usage.

METHOD OF ANALYSIS

The final stage of the cost-benefit analysis was the actual comparison of the projected costs with the estimated potential benefits. To account for the time value of money, a discounted cash flow analysis was performed to determine the present value of both the cost and benefit of the project. If the present value of the benefit exceeds the present value of the cost, then the project should be undertaken. The useful life of the project was estimated to be five years. Five years was a more

conservative estimate than the standard seven year life-cycle recommended by the Department of Navy Bureau of Medicine and Surgery Instruction 5230.5A. By reducing the estimated life-cycle from seven to five years, the costs incurred at the beginning of the project are weighted relatively higher than the benefits received at the end of the project. For ease of comparison with other planned DoD information systems, this study assumed that fiscal year 1997 would be the first year of the project. The project was assumed to begin on the first of October 1996 and continue until the thirtieth of September 2001.

The project was evaluated in terms of real (constant-dollar) cash flows following the guidelines as set forth by the Office of Management and Budget (OMB) in their circular number A-94: Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs (U.S. Office of Management and Budget 1996). This proposed project can be categorized as an "internal government investment," since it should provide "internal" benefits in the form of decreased Federal costs. According to OMB Circular A-94, these types of projects should use the comparable-maturity Treasury rate as a discount rate. The real interest rate on Treasury Notes and Bonds maturing in five years (the expected useful life of this project) is 2.7 percent.

According to Appendix C of OMB Circular A-94, this rate is valid through the end of February 1997 (U.S. Office of Management and Budget 1996).

ANALYSIS OF ALTERNATIVES

In addition to comparing costs to benefits, a survey was conducted to determine if there are any current or planned DoD information systems that have or will have the capabilities of the information system proposed in this study. The survey was conducted from January to June 1996 and involved personal interviews and obtaining Automated Information Sheets (AISs) for various DoD information systems.

CHAPTER 3

THE RESULTS

This cost-benefit analysis finds that the potential cost savings from decreased utilization of diagnostic ancillary and pharmacy services exceeds the estimated costs of developing and maintaining the proposed information system. Using the OMB discount rate of 2.7 percent and assuming a project life of five years, the present value of the estimated benefit is \$2,313,400 while the present value of the total cost is \$313,700 for a positive total net present value (NPV) of \$1,939,700. When the opportunity cost of labor is combined with the variable cost of supplies, the project attains a positive net present value of \$364,700 during the second year. An analysis of the cumulative net present value of the supply benefit indicates that the project attains a positive net present value of \$81,500 in the third year.

ANALYSIS OF BENEFITS

The first benefit analyzed was the potential labor and supply savings associated with primary care utilization of diagnostic ancillary services. This benefit was based upon the Berwick and Coltin (1986) study which observed a 14.2 percent reduction in utilization of laboratory and diagnostic radiology for primary care services provided by a health maintenance organization. This 14.2 percent reduction was applied to clinical pathology and diagnostic radiology usage by Military Sick Call and the Ambulatory Care Clinic as reported by the MEPRS for fiscal year 1995. Table 2 shows that the annual potential savings in labor costs totaled \$137,300. Table 3 shows that the annual potential savings in supply costs totaled \$31,300. Table 4 applied the OMB discount rate of 2.7 percent to these annual savings for the life of the project.

The next benefit analyzed was the potential labor and supply savings associated with outpatient Internal Medicine utilization of pharmacy services. This benefit was based upon the Hershey et al. study (1986) which observed a 6.7 percent reduction in mean charge for a prescription for an outpatient internal medicine service associated with a tertiary care teaching hospital. This 6.7 percent reduction was applied to main pharmacy usage by

Table 2.-- Potential labor savings in diagnostic ancillary costs
for primary care

SEEC	DESCRIPTION	FULL COSTS FY 95	POTENTIAL SAVINGS
MILITARY SICK CALL			
CLINICAL PATHOLOGY			
11.00	Civilian Compensation	\$85,800	\$12,200
11.72	Military Compensation	\$183,300	\$26,000
		<u>\$269,100</u>	<u>\$38,200</u>
DIAGNOSTIC RADIOLOGY			
11.00	Civilian Compensation	\$21,100	\$3,000
11.72	Military Compensation	\$74,800	\$10,600
		<u>\$95,900</u>	<u>\$13,600</u>
AMBULATORY CARE CLINIC			
CLINICAL PATHOLOGY			
11.00	Civilian Compensation	\$126,400	\$17,900
11.72	Military Compensation	\$270,000	\$38,300
		<u>\$396,400</u>	<u>\$56,200</u>
DIAGNOSTIC RADIOLOGY			
11.00	Civilian Compensation	\$45,600	\$6,400
11.72	Military Compensation	\$161,500	\$22,900
		<u>\$207,100</u>	<u>\$29,300</u>
TOTAL LABOR SAVINGS			<u>\$137,300</u>

Table 3.-- Potential supply savings in diagnostic ancillary costs
for primary care

SEEC	DESCRIPTION	FULL COSTS FY 95	POTENTIAL SAVINGS
MILITARY SICK CALL			
CLINICAL PATHOLOGY			
26.20	Other Supplies	\$67,700	\$9,600
26.25	Pharmaceutical Supplies	\$1,100	\$200
		<u>\$68,800</u>	<u>\$9,800</u>
DIAGNOSTIC RADIOLOGY			
26.20	Other Supplies	\$15,600	\$2,200
26.25	Pharmaceutical Supplies	\$300	--
		<u>\$15,900</u>	<u>\$2,200</u>
AMBULATORY CARE CLINIC			
CLINICAL PATHOLOGY			
26.20	Other Supplies	\$99,700	\$14,200
26.25	Pharmaceutical Supplies	\$1,700	\$200
		<u>\$101,400</u>	<u>\$14,400</u>
DIAGNOSTIC RADIOLOGY			
26.20	Other Supplies	\$33,600	\$4,800
26.25	Pharmaceutical Supplies	\$700	\$100
		<u>\$34,300</u>	<u>\$4,900</u>
TOTAL SUPPLY SAVINGS			<u>\$31,300</u>

Table 4.-- Discounted benefit for primary care decreased utilization of outpatient diagnostic ancillary services

Fiscal Year	Labor Savings	Supply Savings	Total Savings
1997	\$0	\$0	\$0
1998	\$133,700	\$30,500	\$164,200
1999	\$130,200	\$29,700	\$159,900
2000	\$126,800	\$28,900	\$155,700
2001	\$123,400	\$28,100	\$151,500
TOTAL SAVINGS	\$514,100	\$117,200	\$631,300

outpatient Internal Medicine as reported by the MEPRS for fiscal year 1995. Table 5 shows that the annual potential savings in main pharmacy labor costs totaled \$21,900 while supply costs totaled \$75,000. Table 6 applied the OMB discount rate of 2.7 percent to these annual savings for the life of the project.

The final benefit analyzed was the potential labor and supply savings associated with inpatient Internal Medicine utilization of diagnostic ancillary and pharmacy services. This benefit was based upon the Billi et al., (1992) study which observed a thirty-six percent reduction in utilization of laboratory services; a four percent reduction in diagnostic radiology; and a one percent reduction in pharmacy services associated with an inpatient internal medicine service at a

Table 5.-- Potential savings in pharmacy costs for outpatient
Internal Medicine

SEEC	DESCRIPTION	FULL COSTS FY 95	POTENTIAL SAVINGS
11.00	Civilian Compensation	\$114,600	\$7,700
11.72	Military Compensation	\$212,400	\$14,200
		<u>\$327,000</u>	<u>\$21,900</u>
26.20	Other Supplies	\$224,200	\$15,000
26.25	Pharmaceutical Supplies	\$895,400	\$60,000
		<u>\$1,119,600</u>	<u>\$75,000</u>
	TOTAL PHARMACY SAVINGS		<u>\$96,900</u>

Table 6.-- Discounted benefit for Internal Medicine decreased
utilization of outpatient pharmacy services

Fiscal Year	Labor Savings	Supply Savings	Total Savings
1997	\$0	\$0	\$0
1998	\$21,300	\$73,000	\$94,300
1999	\$20,800	\$71,100	\$91,900
2000	\$20,200	\$69,200	\$89,400
2001	\$19,700	\$67,400	\$87,100
TOTAL SAVINGS	\$82,000	\$280,700	\$362,700

tertiary care teaching hospital. These observed reductions were applied to clinical pathology, diagnostic radiology, and main pharmacy usage by inpatient Internal Medicine as reported by the MEPRS for fiscal year 1995. Table 7 shows that the annual potential savings in labor costs totaled \$268,700 while the annual potential savings in supply costs totaled \$83,700. Table 8 applied the OMB discount rate of 2.7 percent to these annual savings for the life of the project.

Table 7.-- Potential savings in diagnostic ancillary and pharmacy costs for inpatient Internal Medicine

SEEC	DESCRIPTION	FULL COSTS FY 95	POTENTIAL SAVINGS
CLINICAL PATHOLOGY			
11.00	Civilian Compensation	\$212,700	\$76,600
11.72	Military Compensation	\$454,400	\$163,600
		<u>\$667,100</u>	<u>\$240,200</u>
DIAGNOSTIC RADIOLOGY			
11.00	Civilian Compensation	\$127,300	\$5,100
11.72	Military Compensation	\$450,700	\$18,000
		<u>\$578,000</u>	<u>\$23,100</u>
PHARMACY			
11.00	Civilian Compensation	\$189,700	\$1,900
11.72	Military Compensation	\$351,900	\$3,500
		<u>\$541,600</u>	<u>\$5,400</u>
TOTAL LABOR SAVINGS			<u>\$268,700</u>
CLINICAL PATHOLOGY			
26.2	Other Supplies	\$167,700	\$60,400
26.3	Pharmaceutical Supplies	\$2,800	\$1,000
		<u>\$170,500</u>	<u>\$61,400</u>
DIAGNOSTIC RADIOLOGY			
26.2	Other Supplies	\$93,700	\$3,700
26.3	Pharmaceutical Supplies	\$1,800	\$100
		<u>\$95,500</u>	<u>\$3,800</u>
PHARMACY			
26.20	Other Supplies	\$371,400	\$3,700
26.25	Pharmaceutical Supplies	\$1,483,000	\$14,800
		<u>\$1,854,400</u>	<u>\$18,500</u>
TOTAL SUPPLY SAVINGS			<u>\$83,700</u>

Table 8.-- Discounted benefit for Internal Medicine decreased utilization of inpatient diagnostic ancillary and pharmacy services

Fiscal Year	Labor Savings	Supply Savings	Total Savings
1997	\$0	\$0	\$0
1998	\$261,600	\$81,500	\$343,100
1999	\$254,800	\$79,400	\$334,200
2000	\$248,100	\$77,300	\$325,400
2001	\$241,500	\$75,200	\$316,700
TOTAL SAVINGS	\$1,006,000	\$313,400	\$1,319,400

ANALYSIS OF COSTS

Two vendors (Sherikon, Incorporated and The Bridge Group/Program Support Associates) made tentative proposals to NNMC to design, develop, and implement information systems capable of meeting the requirements for monitoring the utilization of diagnostic ancillary and pharmacy services at NNMC. Sherikon estimated the total cost of the contract to be \$160,000, while The Bridge Group estimated their total costs to be \$365,000 (Burchess 1995). Since the Sherikon proposal met the basic needs of this proposed project for \$255,000 less than The Bridge Group proposal, Sherikon's proposal was used to determine the cost portion of this cost-benefit analysis. Their estimate was based upon building interfaces with the systems listed in the

appendix. A full scale cost accounting system with interfaces that can capture overhead costs and archive capabilities would increase these costs by an estimated one hundred fifty thousand dollars. The only non-contractor related cost associated with the project was the cost for a Government Services system administrator to work with the contractor during the design and implementation phase and to assume responsibility for maintaining system at the end of the first year. Table 9 lists the estimated life-cycle costs of the project. Table 10 applies the OMB discount rate of 2.7 percent to the annual costs for the life of the project.

The project consisted of three phases. The development phase was the initial phase. It was projected to last five months and require the purchase of supporting software and hardware as well as the services of two contractor-provided software specialists. The second phase was the implementation phase. It was projected to last seven months and require the services of one contractor-provided software specialist and one Government Services system administrator. The final phase was the continuing maintenance of the fully implemented information system. This phase was estimated to last four years, which was the projected service life of the system.

Table 9.-- Estimated life cycle costs

FIRST YEAR COSTS (FISCAL YEAR 1997)	
HARDWARE	
File Server	\$5,000
SOFTWARE	
Paradox for programmers and 10 network copies	\$5,000
LABOR	
2 Software specialists for five months (development phase)	\$100,000
1 software specialist for seven months (implementation phase)	\$50,000
1 Government Service Systems Administrator for seven months (implementation phase)	\$28,800
TOTAL FIRST YEAR COSTS	\$188,800
ANNUAL COSTS FOR SUBSEQUENT YEARS	
LABOR	
1 Government Service Systems Administrator	\$49,400

Table 10.-- Discounted cost of information system

Fiscal Year 1997	(\$188,800)
Fiscal Year 1998	(\$48,100)
Fiscal Year 1999	(\$46,800)
Fiscal Year 2000	(\$45,600)
Fiscal Year 2001	(\$44,400)
TOTAL DISCOUNTED COST	(\$373,700)

Determining the Net Present Value

The final phase of the cost-benefit analysis was to determine the net present value of the project based upon a discounted cash flow analysis. The OMB discount rate of 2.7 percent was applied to the estimated benefits and costs for an estimated project life of five years. Table 11 indicates that when variable costs, as represented by the supply benefit, are considered, the project attains a positive net present value of \$81,500 in the third year. Table 12 shows that combining the benefit from the opportunity cost of labor with the benefit from supply costs yields an estimated total benefit net present value of \$2,313,400. Comparing the total benefit with the estimated present value of the total cost (\$313,700) yields a positive total net present value (NPV) of \$1,939,700. When the total benefit is considered, the project attains a positive net present value of \$364,700 during the second year.

Table 11.-- Cumulative and annual supply net present value for the life of the project

Fiscal Year	Cost	Supply Benefit	Cumulative Net Present Value	Annual Net Present Value
1997	(\$188,800)		(\$188,800)	(\$188,800)
1998	(\$48,100)	\$185,000	(\$51,900)	\$136,900
1999	(\$46,800)	\$180,200	\$81,500	\$133,400
2000	(\$45,600)	\$175,400	\$211,300	\$129,800
2001	(\$44,400)	\$170,700	\$337,600	\$126,300
	(\$373,700)	\$711,300		\$337,600

Table 12.-- Cumulative and annual total net present value for the life of the project

Fiscal Year	Cost	Total Benefit	Cumulative Net Present Value	Annual Net Present Value
1997	(\$188,800)		(\$188,800)	(\$188,800)
1998	(\$48,100)	\$601,600	\$364,700	\$553,500
1999	(\$46,800)	\$586,000	\$903,900	\$539,200
2000	(\$45,600)	\$570,500	\$1,428,800	\$524,900
2001	(\$44,400)	\$555,300	\$1,939,700	\$510,900
	(\$373,700)	\$2,313,400		\$1,939,700

Analysis of Alternatives

A survey of existing DoD legacy information systems did not identify any systems that would enable managers and clinicians to monitor the utilization of diagnostic ancillary and pharmacy services on the provider, procedural, DRG, or patient level. A survey of information systems under development revealed the MEPRS/EAS IV and the CHCS II as projects intended to design and implement information systems with capabilities comparable to the system proposed by this study. A distinction between the MEPRS/EAS IV and the proposed information system is that the MEPRS/EAS IV will only be updated with CHCS data on a monthly instead of a daily basis. The MEPRS/EAS IV is scheduled to be deployed during the fiscal year 1998 which would be the same timeframe that the proposed information system is expected to be fully operational (U.S. Department of Defense 1996a).

The CHCS II promises to be "the patient-focused information management system that will capture, provide, and protect all information information needed to deliver health care to DoD beneficiaries anywhere." The CHCS II is being planned to incorporate the functions of all current or planned clinical informations systems and to interface with both the Defense Medical Logistics Standard System (DMLSS) II and Health Standard

Resources System (HSRS) (U.S. Department of Defense 1996b). If this can be done, then the CHCS II should be capable of making timely resource utilization information readily available to clinicians and other decision-makers. However, prototype development of CHCS II will continue through fiscal year 2003 and it is not until fiscal year 2004 that prototyping ends and system maintenance begins (U.S. Department of Defense 1996b). Therefore, the CHCS II will not be fully operational during the expected service life of the system proposed by this study.

CHAPTER 4

DISCUSSION

Analysis of Results

The results from this cost-benefit analysis appear to be a strong endorsement for accepting the hypothesis that it is economically feasible to implement an information system to modify provider ordering behavior resulting in lower, more cost-effective utilization of diagnostic ancillary and pharmacy services. The analysis resulted in a cost to benefit ratio of approximately one to eight. This means that for every dollar that NNMC invests in this project the projected return over the five year life of the project is eight dollars. If labor is considered to be a fixed cost, then over two-thirds of these savings are based upon the opportunity costs of the demand for labor being reduced. The remaining one third of the savings would occur through decreased demand (purchases) of supplies. These supply savings should represent an actual cash flow where funding used to purchase these supplies is available for other purchases. However, these results require some interpretation

and need to be put in the context of other information systems before a decision can be made regarding the course of action for NNMC to follow.

The first interpretation is to distinguish between the direct cost savings associated with reduced demand for supplies and the opportunity cost savings associated with reduced demand for labor. In table 11, the net present value of the potential savings on supply costs was analyzed separately from the net present value of the total benefit. This separate analysis was done because the monetary savings associated with supplies can be easily identified and reallocated to other purposes, such as the purchase of other goods that support mission essential projects such as maintaining medical readiness, developing specialized treatment services, and promoting wellness. The savings on labor costs are not as easily identified nor reallocated to other purchases. For example, a ten percent reduction in the demand for a diagnostic test should result in a ten percent reduction in demand for the reagents (supplies) used to perform that test, but it does not necessarily lead to a ten percent reduction of demand for labor. There are other factors that must be considered to determine the true effect that reducing demand for services has upon labor costs. It should also be noted that labor is

essentially a fixed cost in the short term, so although the benefit analysis predicts that NNMC will experience \$416,600 in labor savings in fiscal year 1998 this does not mean that NNMC can plan on being able to obligate these savings for other purchases. Further analysis would be required to determine the number of full-time equivalent (FTE) military and civilian personnel that could be reduced in the specific ancillary workcenters. Some workcenters may experience the loss of FTEs. For example Clinical Pathology has potential annual savings of \$227,900 in military personnel (approximately four FTEs) and \$106,700 savings in civilian personnel (approximately two FTEs) while Radiology has \$51,500 savings in military personnel (approximately one FTE).

Weaknesses of Study

A fundamental weakness of this analysis is that there are relatively few studies in which the same interventions were used in the same environment. The episodic nature of these studies means that their results may not necessarily be replicated under similar conditions. In reviewing table 1, the Billi et al., (1992) study appears to be an anomaly. With regards to laboratory utilization, it is almost twice the average of the

studies that reported decreased utilization. It is less than half the average of the studies that reported decreased utilization of diagnostic radiology and slightly more than one-tenth of the average of the studies that reported decreased utilization of pharmacy services. The Billi et al. (1992) study was used because it was the only study of inpatient services that used a system similar to the one proposed for NNMC; however, it appears to significantly overestimate the potential reduction of diagnostic laboratory utilization while underestimating the potential reduction in diagnostic radiology and pharmacy services.

Rosenstein and Stier (1991) note that a ten to twenty percent reduction in the utilization of ancillary services appears to be the norm when education is combined with feedback. If a ten percent reduction is applied to the total ancillary supply and labor costs associated with inpatient Internal Medicine then the potential reduction would be \$178,700 in labor costs and \$211,700 in supply costs for a total reduction of \$390,400. This potential reduction is \$38,000 more than the reduction reported applying the percentage from the Billi et al. (1992) study. Although the Billi et al. (1992) results may not be replicated, they are still the more conservative results upon

which to base a cost-benefit analysis. However, for planning purposes, NNNMC should not use the Billi et al. (1992) study to determine staffing levels for the ancillary services.

There is also a potential error in estimating the costs associated with developing a new information system. This analysis does not take into consideration the costs associated with updating system interfaces as they change, so the cost of maintaining the system is likely to be underestimated. Also, the risk inherent in developing a new information system was not quantified (i.e., that is the risk that the contractor may not be able to deliver a product that meets expectations given funding and time constraints).

Potential Applications

The proposed system could be used to develop standard treatment protocols and identify cost-effective departments that could be rewarded through an incentive system that allows them to retain some of their savings. For example, withhold pools could be established from departmental budgets for ancillary services and any excess funds could be used at a department head's discretion for items of interests such as continuing medical education or minor equipment.

The proposed system could also support the ongoing provider profiling project that NNMC is doing in conjunction with the IAMETER consulting firm. IAMETER is providing retrospective information on provider usage of ancillary services for designated DRGs. The proposed information system would be able to provide daily feedback during the inpatient stay; thus, enabling providers to compare their actual resource utilization against a pre-determined standard. This concurrent information would allow providers to alter the course of treatment during the inpatient episode of care. The Billi et al., (1992) and the Pugh et al., (1989) studies have shown this to be an effective method of reducing the utilization of ancillary services. Providers with high utilization patterns could be readily identified for follow-up comparison adjusted for patient acuity. This system could also be used to determine if decreased lengths of stay are decreasing costs as much as anticipated, or whether more diagnostic tests are being performed in a shorter amount of time.

The proposed information system will be useful in supporting cost control by making the information readily available to clinicians. It will not only provide the information needed to determine the costs of critical pathways but can also serve as a monitoring tool to identify and analyze variances from the

critical pathways (Meyer and Feingold 1995). The literature indicates that critical pathways, as a single intervention, are ineffective in changing provider ordering behavior; however, when feedback and education were added as interventions the effectiveness of critical pathways increased significantly (Greco and Eisenberg 1993; Davies et al. 1992).

This proposed information system by combining cost information with utilization information will have a myriad of uses. It can support TRICARE requirements by providing information to help identify cost-effective services. This could help NNMC to decide which product or service lines to develop or continue to support. The system can be used to transform the current level of responsibility that clinicians and clinical department heads have for resources. Currently, NNMC clinical department heads have responsibility for equipment, supplies, and continuing medical education funds utilized by their departments. They have no responsibility and are not held accountable for their providers' usage of diagnostic ancillary and pharmacy services. While the current system does not provide any direct incentives to over-utilize those resources, it also does not provide any incentives or monitors to curb the over-utilization of those resources. This proposed information system can be

applied to increase physician accountability for the resources that they consume in the delivery of health care. This increased level of physician accountability is consistent with recommendations found in the literature review (Young and Pearlman 1995; Meyer and Feingold 1995; Rosenstein and Stier 1991).

Analysis of Current Systems

The information systems currently in use within the DoD lack the capability of combining cost and utilization information. The current MEPRS/EAS III is a top-down approach to cost accounting. It is similar to a first stage cost accounting system described by Young and Pearlman (1993). The MEPRS/EAS III is the DoD version of the general ledger used to determine costs, workload, and manpower at the cost center level. It focuses exclusively on total costs and cannot distinguish between fixed and variable costs (Miller 1996). The MEPRS/EAS III does not provide sufficient detail so that costs can be aggregated in different ways, and it lacks the capability to apply ratio to individual procedures to determine their cost. The MEPRS/EAS III does not aggregate costs according to the provider, so it cannot support resource control and utilization review at the provider

level.

The CHCS does allow for aggregating information according to DRG, provider, and/or clinical department but there is no means to attach cost data to this information. The CHCS uses relative value units (RVU) to determine the workload for laboratory and radiology procedures and this information is supplied to the MEPRS/EAS III.

Analysis of Future Systems

The Medical Expense and Performance Reporting System (MEPRS)/Expense Assignment System, Version IV (EAS IV) is being developed as the follow-on system for the MEPRS/EAS III. The MEPRS/EAS IV is intended to shift military health care cost accounting from a top-down first stage cost accounting system into a third stage bottom-up system with a patient level cost allocation functionality. The MEPRS/EAS IV will provide more detail cost information than the current MEPRS/EAS III. The MEPRS/EAS IV is intended to provide sufficient cost detail to allow decision makers to evaluate managed care alternatives (make, buy, or transfer services), enhance third party reimbursements, and support the analysis of provider resource utilization. The migration from MEPRS/EAS III to MEPRS/EAS IV is

expected to be completed by FY 1998 (U.S. Department of Defense 1996a).

The MEPRS/EAS IV will receive inputs from the following systems on a monthly basis:

1. Standard Accounting and Reporting System - Field Level (STARS/FL) obligates funds and tracks disbursements
2. Standard Personnel Management System (SPMS) provides manpower and personnel information
3. Composite Health Care System (CHCS) reports utilization information
4. Defense Medical Human Resource System (DMHRS) is the migration system that will replace SPMS for providing manpower and personnel information
5. Military Health Care Management Information System (MHCNIS) interfaces with a variety of systems to provide information for meeting TRICARE requirements, improving the quality of care, and containing costs
6. Ambulatory Data System (ADS) provides information regarding outpatient care
7. Workload Management System for Nursing (WMNS) classifies inpatient acuity, determines nursing staff requirements, and tracks workload by floor and facility (U.S. Department of Defense

1996a)

The MEPRS/EAS IV will use RVUs to determine a weighted cost per RVU diagnostic ancillary services at the patient level. For pharmacy, they will use "weighted workload" (five weights are assigned that vary from a weight of one for outpatient workload increase as the complexity of inpatient workload increases). The MEPRS/EAS IV is also proposing that the gateway from ADS be made bi-directional so that the CHCS can be updated with CPT information. The cost of supplies will be determined by a weighting method based upon patient acuity. Salaries will also be allocated to patients using acuity from the WMNS. The MEPRS/EAS IV will receive monthly downloads from CHCS. The MEPRS/EAS IV is expected to be able to allocate over eighty percent of costs directly to patients with all of the costs for ancillary services being stepped down directly to patients (Kelly 1996).

The proposed system would be expected to come on-line during FY 1998, which is the same timeframe that MEPRS/EAS IV is expected to be available at NNMCM. The proposed information system can provide better feedback than the MEPRS/EAS IV because it will receive daily updates from the CHCS and be accessible to providers via NNMCM's LAN. The Tierney, Miller, and McDonald

(1990) study concluded that physicians need continual reminders of the charges for tests in order to maintain their awareness of these costs. A review of the literature indicates that monthly feedback is often ineffective for changing provider ordering behavior (Parrino 1988; Cohen et al. 1982). In both the Parrino (1988) and the Cohen et al., (1982) studies, feedback provided on a monthly basis had no effect on altering provider ordering behavior. The Pugh et al., (1989) and Billi et al., (1992) studies are examples of successfully using feedback during the patient's inpatient stay. Parrino (1989) predicted that concurrent instead of retrospective feedback might have yielded better results. None of the summary articles (Eisenberg and Williams 1981; Davis et al. 1992; Greco and Eisenberg 1993; Davis et al. 1995) commented upon the effect that lag time has upon modifying provider behavior. This would be an area for further research.

The major benefit that the proposed system offers that is not available through the MEPRS/EAS IV is the increased timeliness and frequency of feedback. The availability of daily feedback makes it possible to manage the patient's care during the actual inpatient episode of care. This should increase the effectiveness of the critical pathways that are being developed

at NNMC (Davis et al. 1995). A feedback mechanism is required for critical pathways to achieve their desired outcomes (Davis et al. 1992). The Parrino (1988) and Cohen et al., (1982) studies are examples where desired outcomes were not achieved because the feedback was not timely. The Cohen et al., (1982) study shows that, even for a group of motivated physicians, weekly feedback was too long of a delay for improving their performance. The Davis et al., (1992) study noted that physicians require continual feedback in order to modify their behavior. The study noted that physicians return to their baseline level of ordering tests unless they received continual reminders.

Due to the comprehensive nature of the MEPRS/EAS IV, there does not appear to be significant value added by creating this proposed information system. The two systems would be very redundant with two separate contractors being paid to build the same system interfaces. Almost all of the information system interfaces required by the information system that is described in the appendix are also required interfaces for the MEPRS/EAS IV. Since the MEPRS/EAS IV will be a standard DoD system, any upgrades to system interfaces are included in the life-cycle costs, but upgrades to the proposed system would require a separate contract if they occur after the initial

development phase of the project. The other advantage of being a DoD standard system is that, unlike the proposed system, NNMC will not have to fund any of the costs for design, implementation, or maintenance.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

This cost-benefit analysis indicates that the benefit of an information system for monitoring provider utilization of diagnostic ancillary and pharmacy services outweigh the costs associated with designing, implementing and maintaining the system. The benefit from this system should occur by utilizing information that is derived from point-of-care data collection to provide feedback that modifies the ordering behavior of clinicians. By modifying the ordering behavior that contributes toward unnecessary utilization of diagnostic ancillary and pharmacy services, NNMC should be able to provide high quality care at lower costs.

A system for monitoring provider utilization of ancillary services is necessary but not sufficient to change provider ordering behavior. If it is used as the feedback mechanism to reinforce educational efforts regarding the cost-effective practice of medicine, then the chances for success of such a

program are greatly increased (Greco and Eisenberg 1993; Davis et al. 1995). The benefits anticipated in this analysis are not likely to occur unless the system is used as an integral part of an educational program designed to modify provider behavior.

An information system, that monitors provider utilization, will support ongoing initiatives at NNNMC such as critical pathways and provider profiling. It may also be used to support activity-based costing efforts aimed at re-engineering the delivery of health services. Perhaps, the most important aspect of such a system is that it will give department heads and providers the information that they need to assume responsibility for managing the resources that they utilize in the delivery of health care.

Another potential application for this system would be as a cost accounting system to provide information for management decisions. It would be able to provide a greater level of detail concerning the costs associated with procedures, DRGs, and provider practice patterns than the current MEPRS/EAS III. A comparison was also made of the system, as described in the appendix with the MEPRS/EAS IV that is currently under development. The comparison revealed that the system as described in the appendix will have capabilities that are very similar to

the MEPRS/EAS IV. In comparing the two systems, the MEPRS/EAS IV will offer a more complete cost accounting system with a patient-level cost accounting capability. It will have interfaces with more data sources and offer a complete archive capability. The MEPRS/EAS IV will also be a DoD standard system, so support should be more readily available. Both of the systems should be available for NNMC to use during the fiscal year 1998 timeframe. The only significant advantage that the system described in the appendix has to offer is that it receives daily updates concerning the usage of ancillary services, while the MEPRS/EAS IV will only receive that type of information on a monthly basis. This is an area for further research to determine what is the most effective time lag for providers to receive feedback.

Recommendations

This analysis recommends that NNMC use the MEPRS/EAS IV to monitor utilization of ancillary services, instead of initiating actions to have another information system developed. This recommendation is based upon the high degree of redundancy between the two systems. The DoD will gain very little benefit from paying two separate contractors to develop extremely similar systems. However, the research for this study does indicate that

there are benefits associated with daily feedback of provider utilization information; therefore, this study recommends that a request be made to the Secretary of Defense for Health Affairs Office to modify the requirements for the MEPRS/EAS IV to allow for daily updates of data from the CHCS instead of the current monthly requirement.

Another recommendation is to utilize the information systems that are currently available more effectively to monitor the utilization of ancillary services. For example, the CHCS can be used to generate ad hoc reports that could be used as part of a monitoring system. If a preliminary DRG was entered into CHCS soon after a patient's admission, then a predetermined ad hoc report could be generated on a daily basis. The ad hoc report would be a summary of the ancillary services received by the patient. This report would then be placed in patient's chart where it could be compared with the critical pathway for that patient. This approach is very similar to the feedback that was successfully used in the Pugh et al., (1989) and Billi et al., studies (1992).

APPENDIX

CONFIGURATION OF PROPOSED SYSTEM

The proposed system will reside on a file server connected to NNMC's existing local area network (LAN). Mark Burchess, of Sherikon, recommended that PARADOX for programmers be the software used for writing the program. System users will access the system using network-based PARADOX (database software) installed on microcomputers previously purchased by NNMC for other purposes. Initially ten copies of network-based PARADOX will be purchased and installed, but more copies can be purchased and installed if the demand is justified. By using existing communication capabilities and microcomputer, the costs of establishing and maintaining the system will be minimized. The system will record data from both inpatient and outpatient activities. The system will collect and provide information regarding the costs of care and users will be able to graph the data using the graphing capabilities of PARADOX.

Interfaces will be developed for the following information systems that are currently or anticipated to be installed prior to the development phase of this project:

System	Data to be provided by System
CHCS	Patient Identifier
	Provider Identifier
	Name of Clinic (work center)
	DRG
	Pharmacy Orders
	Laboratory Orders and their RVUs
	Radiology Orders and their RVUs
	Patient Appointments
	Registration Number for inpatients
ADS	CPT code
	Patient Identifier
	Name of clinc (workcenter)
	Provider Identifier
EAS III	RVU cost per weighted laboratory procedure
	RVU cost per weighted radiological procedure based
	RVU cost per weighted ancillary

System	Data to be provided by System (continued)
SURGI-SERVER	Usage of Operating Room supplies Provider Identifier Patient Identifier
AWSN	Patient Acuity Nursing workload
SPMS	Cost of nursing labor hours by workcenter
CPD	Clinic (workcenter) orders for supplies
FCS	Cost of pharmaceuticals Cost of supplies Cost of Operating Room supplies

INFORMATION PROCESSING FOR PROPOSED SYSTEM

1. Daily download of data from CHCS, ADS, CPD, SURGI-SERVER, and AWSN into PARADOX database
2. EAS III, FCS, and SPMS cost information is built into files and tables of PARADOX database. This information is updated as it changes.
3. In PARADOX database, cost information from EAS III is attached to diagnostic ancillary orders. Cost information from FCS is attached to pharmacy orders.
4. The cost for consumables is based upon CPD job order number for work centers. Daily issues from CPD are charged to work centers and these costs are then divided by the total number of patients treated by that service adjusted for acuity as reported by AWSN. The assumption is that patients with higher acuity consume a relatively higher amount of supplies. A smoothing factor will need to be applied to CPD's perpetual inventory to standardize the consumption of consumable supplies. For example, when wards are not restocked on weekends.
5. Daily downloads from AWSN would be required for inpatient acuity. The register number would link with CHCS because AWSN does not use social security numbers as patient identifiers. Workload information from AWSN would be attached to

cost information from SPMS to determine the costs for inpatient nursing care.

6. Standard reports can be retrieved by LAN users. Reports can identify costs per patient, per provider, per clinic, per DRG, and per CPT.

7. LAN users with access to the PARADOX software can retrieve their own information and design their own reports.

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